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THE SCIENTIFIC APPROACH

I. What is meant by factfinding?

So much will be said and oft repeated in this course about factfinding, research techniques, straight thinking, and similar expressions to denote the scientific processes involved in evaluation, that it becomes desirable at the outset to examine briefly what such terms mean. How may the scientific approach to problem solving be distinguished from other and presumably nonscientific approaches? A good practical statement of what we are thinking about in extension evaluation when we emphasize the factual approach is found in How to do Research Work, by W. C. Schluter. It is a quoted statement credited to Franklin H Giddings:

> "The scientific study of any subject is a substitution of business-like ways of 'making sure' about it, for the lazy habit of 'taking it for granted' and the worse habit of making irresponsible assertions about it. To make sure, it is necessary to have done with a careless 'looking into it,' and to undertake precise observations, many times repeated. It is necessary to make measurements and accountings, to substitute realistic thinking (an honest dealing with facts as they are) for wishful or fanciful thinking (a self-deceiving day-dreaming) and to carry on a systematic 'checking up.' . . . Science is nothing more than getting at facts, and trying to understand them."

The following statement of Owen D. Young when dedicating a new building at Johns Hopkins University several years ago highlights the value of facts as a guide to all action.

> ". . . facts can be applied in any field. Our curse is ignorance. Facts are our scarcest raw material.. This is shown by the economy with which we use them. One has to dig deep for them, because they are as difficult to get as they are precious to have."

II. Is it so? attitude.

The scientific approach is the questioning approach. Is it so? is the basic requirement of the scientific method. That test must be constantly applied to the data already available from experience and to the new data collected in accordance with accepted scientific procedures in an effort to resolve doubts and contradictions and to supply the missing data necessary to complete understanding of the matter. The approach is objective. It aims to substitute facts, derived with accuracy and definiteness of details,

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for opinion. The ideal of scientific measurement is to be able to express things in quantitative terms.

> "When you can measure what you are speaking about in numbers, you know something about it, but when you cannot measure it - when you cannot express it in numbers, your knowledge is of a meagre and unsatisfactory kind." - Lord Kelvin.

There is certainly no substitute for numbers when one is seeking a satisfactory answer to questions of - How much? How far? How large? To what extent? - and the like - about a thing.

III. The art of scientific thinking.

Of the many ways writers have attempted to explain the principles underlying straight or sound thinking, perhaps the pungent statements of Glenn Frank summarize the matter as well as any:

> "Thinking is an adventure in fact-handling."
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> "First, we must find the facts. We must not prejudge things in terms of our conservatism, our liberalism or our radicalism. We must not decide in advance that we are to be conformists or nonconformists on any issue. We must begin by finding the facts, for we cannot fly in the face of the facts without courting ultimate disaster.
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> "Second, we must focus the facts. Facts are not important for their own sake; they are important only as a basis for human action. We must be more than mere cataloguers of facts. Our brains must be more than cold storage plants for unrelated stores of information. We must focus the facts we find upon the issues we face.
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> "Third, we must filter the facts. We must contrive to separate the facts from admixtures of prejudice, passion, partisanship and selfish interest. Facts that are diluted, colored, or perverted by these factors are valueless as a basis for action.
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> "Fourth, we must face the facts. It is sometimes hard for us to look a fact in the face without blinking. But we must learn that the energy spent in trying to find ways to get around, under or over the facts is wasted energy. Facts have a ruthless way of winning the day, sooner or later. It is better to face them frankly at the out-set.
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> "Fifth, we must follow the facts. We must say of facts as Job said of God: 'Though they slay us, yet shall we trust them.' If the facts threaten to upset our cherished plans, it will pay us to reexamine our plans. This way lies realism, and realism is the ultimate good."

The "Five F" route is not the easy road to travel. Thomas A. Edison, in addition to being the world's leading scientist, was also a good judge of human nature when he stated: "There is no expedient to which a man will not go to avoid the labor of thinking."

IV. Steps in the scientific approach to a problem.

Regardless of whether the problem being studied is relatively simple or complex, the fundamental steps in the procedure are the same:

A. Defining the problem.

Before one can intelligently set about marshalling facts relating to a problem, one must really understand the nature of the problem being dealt with. Not only must the problem be clearly defined, but there must be a clear-cut delineation of the specific aspects or phases of the problem it is intended to study. Once the problem has been accurately identified it becomes important to know what information on the problem has been contributed by previous research. Such information contributes to a clearer understanding of the nature of the problem and avoids meaningless duplication. Light is also thrown on the kind of new or additional data needed to arrive at a satisfactory solution to the problem. The objective of the research effort stated in clear terms indicates the direction to be taken, and makes possible the devising of guesses, suppositions, tentative inferences, to serve as working hypotheses or guides for proceeding. These early suppositions will, of course, need constant revision, and often replacement by new working hypotheses as the investigation progresses. Nobody knows what to look for unless he has ideas. Facts do not stream into "empty minds." An "open mind" is suggestive of an "empty stomach."

B. Collecting the facts.

Having determined the objective of the study following an analysis of the situation, and having developed certain working hypotheses, the next step in the solution of any problem is the collection of facts to develop these suppositions and to prove or disprove them. The sources of information open to the person seeking facts may be direct, such as personal observation and experimentation, or indirect, including bibliographical research, interviews, and questionnaires. The nature of the problem up for solution will, of course, influence the method of data collection. Several sources of information will be involved in many problems encountered in extension evaluation.

C. Classifying and tabulating the facts.

The systematic classifying, testing and tabulating of the data collected are closely related to the working hypotheses developed in step one. In fact, the thinking through of the problem when the objective is being clarified and when the nature of the data to be collected is

being determined, should include consideration of the basis to be used in classifying and tabulating the data when collected--the listing of the related factors, and the assembling of the facts under their proper divisions. Plans for classifying and tabulating the data will, of course, need revising as the working hypotheses are modified or replaced as the investigation proceeds. Unless, however, the treatment of the data is visualized in advance, there is serious danger that important items of information will not have been collected, the forming of conclusions thereby limited.

D. Forming conclusions.

The collecting and tabulating of facts are not ends in themselves - only means to an end. The purpose of investigation is to discover something, the working out of the solution of a problem. From the facts which have been focused on the problem one draws inferences, develops additional hypotheses, gathers more facts, and continues this process until definite conclusions are arrived at. Until the conclusion is absolutely established the mind remains open to new ideas, and alert to see the problem from fresh angles. In this way, unsuspected facts are unearthed which might otherwise be overlooked. Just as soon as the conclusion begins to take tangible form it should be put into words. Once stated in definite terms the idea is clarified and it becomes possible to establish its truth or falsity. No matter how interesting the conclusion may be, it is useless for practical purposes if it cannot be tested out and verified.

E. Testing and verifying conclusions.

The final stage in the research cycle, that of verification of the conclusion, calls for deductive reasoning. The arriving at a conclusion after careful analysis of the facts assembled to prove or disprove the suppositions or working hypotheses set up as guides in the early stages of the investigation is mainly a question of inductive reasoning - "What is true of the many, is true of the whole." Through deliberate methods of inquiry inferences and suggestions are examined in an effort to ascertain the true cause of certain effects noted, or the effects produced by known causes. The objective is the "finding of the causal relationship." In the deductive reasoning approach the reverse process of thinking is employed - "What is true of the whole, is true of the part." The inference which is established through inductive methods is assumed to be true and taken up as the hypothesis. Other facts are gathered and related to this hypothesis. If the conclusion or hypothesis accounts for all the facts it is considered as true. In other words, before the concluding hypothesis is accepted as the true findings of the investigation, that hypothesis must be checked against other known facts and established principles.

The steps followed in conducting research represent an orderly approach to problem solving. The thought process used by the research worker is the same as by any individual and, therefore, presents no

mystery. Because each step leads naturally to the next, the scientist observes more critically, classifies more accurately, is surer of his judgments, and draws upon wider sources for his inferences. No matter how limited or how extended the scope of the investigation the basic procedure is the same.

V. Major research methods.

As pointed out in Chapter V, Methodology of Educational Research, by Carter V. Good, A. S. Barr, and Douglas E. Scates, the methods of conducting research may be classified in may ways, depending upon the point of view, i.e., the fields to which applied, purpose, place, data-gathering devices employed, character of data, etc. Many examples are given of classifications of techniques employed by educational research workers. The following classification of major research methods suggested by Good, Barr, and Scates, will serve the purpose of this lecture as well as any and has the additional advantage of simplicity. The choice of techniques of collecting the data will, of course, depend upon the problem under study. "Frequently several modes of attack must be employed in the collection of data adequate for the solution of a problem."

A. Historical research.

Direct observation as an eyewitness and indirect observation through documents, remains, and other eyewitnesses, analytical bibliographies and summaries of various kinds come under this heading.

B. Normative-survey research.

Questionnaires, tests, rating scales, score cards, interviews, etc., are employed for the purpose of making comparisons, for revealing central tendencies, for making predictions of future performance, and sometimes for determining causes of present conditions. The underlying purpose is the establishment of an authoritative standard, pattern, or rule. The normative-survey method is widely employed in studies of social and educational problems, including extension.

C. Experimental research.

Controlled observation and measurement are involved. The logical principle of "difference" is employed. All factors save one are controlled and equated so differences resulting from the operation of the single variable can be noted. The so-called laboratory method is an intensive form of experimental research.

D. Other methods of research especially adapted to studying complex causal relationship.

The effect is observed and the cause sought. Causal-comparative relationships involve the logical principle of "agreement," situations being compared to discover likenesses or common factors. Correlation.

analysis provides the statistical approach to causal relationships. The case method borrowed from medicine and law places emphasis on diagnosis and the intensive analysis of many individual cases may result in the establishment of central tendencies as in the survey method. The genetic method of research involves a series of observations or cross-sections; is used principally on long-time investigations of biological phenomena. The genetic method may at times assume aspects of the survey and experimental methods. The case and genetic methods often involve the historical approach also.

VI. Balance and proportion essential

In concluding this discussion of the scientific approach we would emphasize with vigor and force the very great importance of that all too uncommon quality of "common sense." The major purpose of extension evaluation is the search for valid, reliable and objective information useful in improving the organization and conduct of extension teaching. Applied research is merely a means of constantly improving efficiency and raising standards of accomplishment in extension.

In employing the factfinding approach we must endeavor at all times to retain our sense of proportion and to maintain proper checks and balances. If the extension problem is of minor importance, the estimated cost of making the study large, and the probability slight of a solution being found of much practical value, it will be wiser to redirect our thinking into a more profitable channel.

Where facilities for tabulation are limited, judgment should be exercised in the length of the survey questionnaire and the number of interviews obtained. Perhaps a limited number of questions answered by a relatively small sample will provide all the information needed.

Failure to think through the purpose of the study and to plan analysis tables in advance may result in the omission of key data necessary for the forming of conclusions. Undue refinement in statistical analysis becomes ridiculous if the original data cannot be obtained with a high degree of accuracy, or if only the establishment of general trends is desired. Large studies should not be launched without pretesting the questionnaire. Skillful interviewing cannot offset a hazy objective and faulty sampling. Additional time spent on drawing a representative sample beyond that necessary to insure the degree of statistical accuracy required by the study is largely wasted. One or two detailed case studies, no matter how skillfully made, do not insure the accuracy of the conclusion.

But, perhaps, enough has been said to point out the danger of being carried away by a research fad or style prevalent at the moment. Scientific thinking is just as applicable to the problem of selecting appropriate study techniques as to finding solutions to extension problems.

Extension evaluation should, of course, be carried on in accordance with accepted standards for scientific investigation of social science problems.

Special training for extension research is highly desirable. We need more of it. But training in research thinking and procedure cannot substitute for the personal knowledge and experience acquired in the actual conduct of extension. We must not minimize the contributions which good judgment and balance can contribute to evaluation.

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